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Distribution, Species Composition, and Abundance of Waterfowl Wintering in The Parsnip River Drainage, 2000

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1.0 Introduction

The Williston Reservoir watershed in north-central British Columbia (BC) provides a variety of lakes, rivers, and wetland habitats that support many wildlife species whom are dependent on water or water-associated habitats to provide their life requirements. In winter, however, when ice and extreme cold limit the ability of these species to sequester their food resources and necessary cover (thermal and escape), many of those species less equipped to deal with winter either migrate to more hospitable coastal or southern climes (e.g., ospreys *[Pandion haliaetus]*, passerines) or invoke alternative behaviours to cope (e.g., brumation of amphibians). Nevertheless, instead of migrating with their conspecifics prior to winter's onset, some waterfowl linger behind and rely on the few areas that remain ice-free through winter. Consequently, ice-free areas play an integral role in the survivorship of these individuals that remain throughout the winter as these sites provide feeding, escape, and thermally favourable habitat.

The suitability of a watercourse to provide wintering habitat is, however, not solely reliant on the presence of ice-free sections. For example, for feeding, ice-free areas with deeper and faster moving water can likely be used by diving species, such as goldeneyes *(Bucephala* spp.), common mergansers *(Mergus merganser)*, and American dippers *(Cinclus mexicanus)*, but not by dabblers. Dabblers, like trumpeter swans *(Cygnus buccinator)*, Canada geese *(Branta canadensis)* and mallards *(Anas platyrhynchos)*, require shallower and slower moving water sites for feeding.

The winter presence of trumpeter swans in the Williston Reservoir watershed is of particular interest. Once widespread and abundant across North America, human-induced pressures caused trumpeter swan numbers to decline to almost extinction, thereby garnering them protection status in the early 1900s (Campbell et al. 1990, CWS 1992, Bellrose 1976). Only 127 trumpeter swans were known to be breeding in Canada and the United States in 1933 (CWS 1992), though the Pacific Coast Population that breeds in Alaska was not known at the time (Anonymous 1999). Trumpeter swans have responded well to an international conservation effort and their population has grown to over 19,000 birds in 1996 (Caithamer 1996 and Subcommittee on the Interior Population of Trumpeter Swans 1997 *in* Anonymous 1999). The trumpeter swan was removed from the endangered species list by COSEWIC in 1996 (Anonymous 1999), but are still blue-listed and designated as *Identified Wildlife* in BC because of their relatively few breeding pairs in BC and the vulnerability of key wintering habitats (CDC 2000, Forest Practices Code of BC 1997).

The Central Interior of BC provides the northern-most wintering grounds for trumpeter swans in North America, with at least 500 swans over-wintering annually at open-water sites in the area bounded by Prince George and Francois Lake in the south and the Crooked River and Takla Lake in the north (King 1981, McElvey and Burton 1983). A survey of this area counted 975 swans during the relatively mild winter of 1990; the highest count of swans (78) in the Williston Reservoir watershed was also recorded at this time (Ministry of Environment, Lands and Parks [MELP], unpublished data).

The importance of ice-free areas to wintering waterfowl, particularly during extended periods of cold temperatures, prompted the PWFWCP to conduct a late winter survey of ice-free areas within the Williston Reservoir watershed. The intention of the survey was to identify key ice-free areas available in the watershed (i.e., areas that remain ice-free throughout the winter and in most years) and determine the distribution, species composition, and abundance of water-dependent wildlife using these sites. This report documents the surveys conducted within the Parsnip River drainage of the Williston Reservoir watershed during January and February 2000.

2.0 Survey Area and Methods

In an attempt to identify all watercourses within the Williston Reservoir watershed that may have ice-free areas present, local residents, aircraft pilots, and personnel from resource agencies familiar with the watershed were contacted for their input (Appendix A). Numerous potential ice-free areas were identified throughout the watershed. Since all areas could not be surveyed due to funding limitations, each site identified was ranked based on its likelihood to be ice-free throughout winter and its potential to be used by wildlife, particularly trumpeter swans and other waterfowl (Appendix B).

Criteria employed to help determine the site capability rankings were 1) the regularity with which a site was reported to be ice-free throughout winter, 2) the potential size of the ice-free site (i.e., the larger the better), 3) the location of the site (i.e., wildlife use and open water less likely further north), 4) the prior known use of the site by wintering waterfowl, 5) the suitability of the site for use by wildlife (e.g., slow moving and shallower water), and 6) the contributor's knowledge of the area in winter. Areas that were consistently reported to be ice-free throughout most winters and that had characteristics favourable to waterfowl were ranked high. Based on this ranking system, sites along river systems in the Parsnip River drainage were ranked highest (Appendix B).

The main areas targeted to be surveyed were - (Figure 1)

- the Crooked River system, between Summit Lake and McLeod Lake,
- the McLeod Lake/Pack River system, between McLeod Lake and the Williston Reservoir,
- the outlet of Tacheeda Lakes,
- the Nation River, including the outlet of Chuchi Lake,
- the outlet of Morfee Lake, and
- the Parsnip River, between the Williston Reservoir and Arctic Lake.

Areas surveyed in the Parsnip River drainage were situated along larger river systems from 868 m (Chuchi Lake) down to 672 m (Williston Reservoir) in elevation, except for the Tacheeda Lakes (726 m) and Morfee Lake (716 m) outlets that were located on smaller tributaries. All sites are situated within the moist-cool or wet-cool Sub-Boreal Spruce biogeoclimatic subzones (SBSmkl, mk2, and wk2; MacKinnon et al. 1990, DeLong et al. 1993). Ice-free sites in the Parsnip River drainage are the consequence of warm water springs, faster flowing water, and warmer water exiting from lakes (King 1981, F. Corbould, PWFWCP, personal observation).

Freezing conditions in the Williston Reservoir watershed typically begin in October and last until April (Davidson and Dawson 1990), with minimum temperatures reaching -35 to -45°C during the November to March period (Environment Canada 1998). Normal temperatures (30-year averages, 1961-1990) for January and February at Prince George are between -1°C and -14°C (Table 1; Environment Canada 1998); data for January and February normal

Table 1. Mean monthly winter temperatures (1999/2000 and 30-year normals[a]) for Prince George and Mackenzie (Environment Canada 1998 and 2000).

	Mean monthly temperatures (°C)									
	November		December		January		February		March	
	1999	Normal	1999	Normal	2000	Normal	2000	Normal	2000	Normal
Prince George										
Maximum	3.9	0.6	0.2	-4.5	-7.6	-5.8	-0.9	-0.7	5.2	4.6
Minimum	-2.7	-6.8	-6.7	-12.5	-15.8	-14.1	-10.7	-10.3	-3.2	-6.0
Mean	0.6	-3.1	-3.3	-8.4	-11.7	-9.9	-5.8	-5.4	1.0	-0.7
Mackenzie										
Maximum	1.0	-1.6	-1.2	-6.4	-9.1	n/a	-1.1	n/a	3.9	2.5
Minimum	-4.3	-7.8	-8.2	-14.0	-17.9	n/a	-12.6	n/a	-5.2	-9.4
Mean	-1.6	-4.6	-4.7	-10.1	-13.5	n/a	-6.9	n/a	-0.6	-3.4

[a] Monthly 30-year normals are for the period 1961 to 1990.

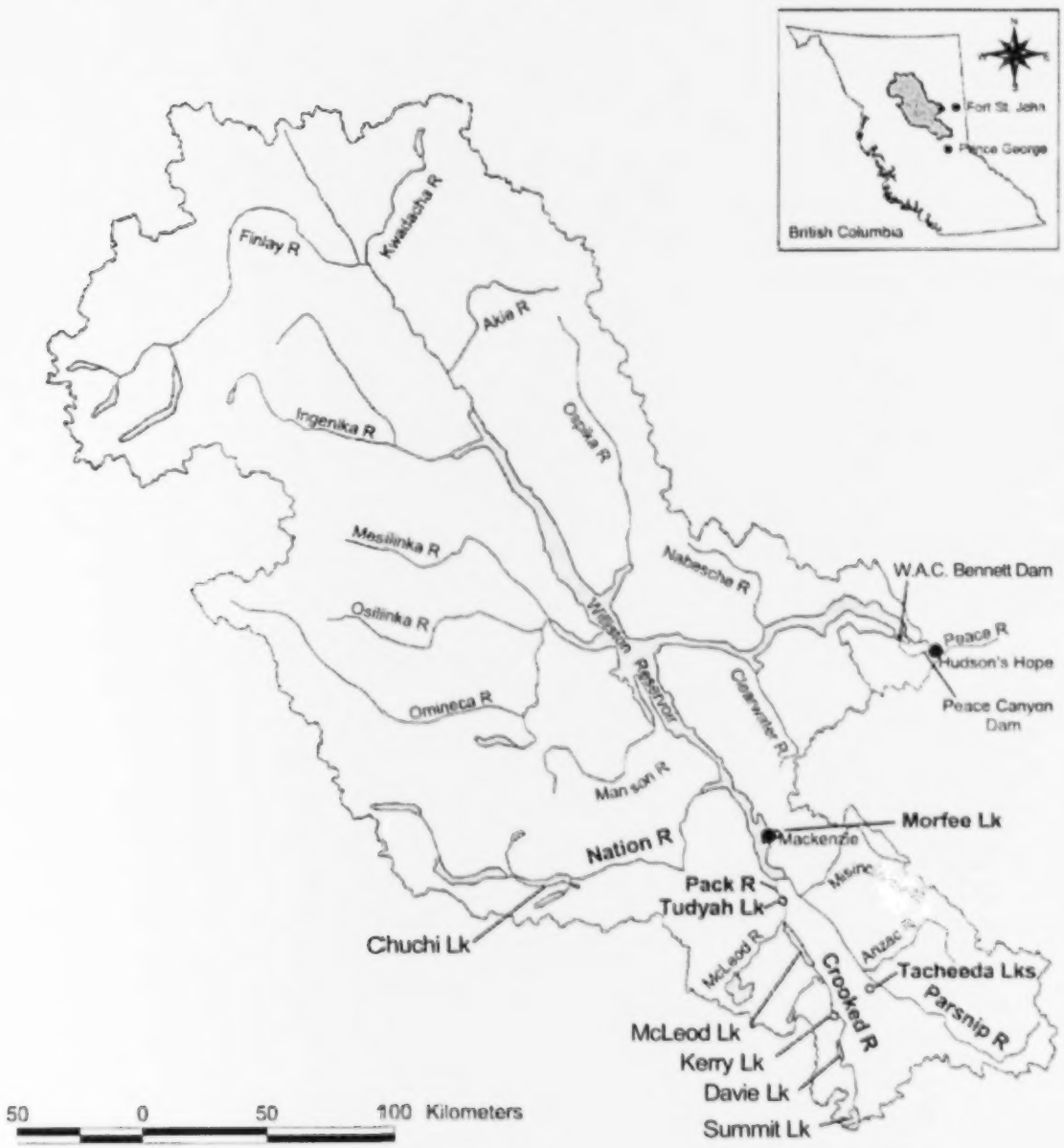

Figure 1. Areas surveyed within the Parsnip River drainage of the Williston Reservoir watershed, 26 January and 18 February, 2000: Crooked River, Tacheeda Lakes, McLeod Lake/Pack River, Parsnip River, Morfee Lake, and Nation River/Chuchi Lake.

temperatures were unavailable for Mackenzie but are likely a couple of degrees colder than Prince George.

In order to ensure that key or core ice-free areas (i.e., areas open all winter and years) would be identified, surveys were scheduled to be conducted in late winter after an extended cold period (e.g., ≥10 days of average temperatures colder than -20°C). The local and forecasted weather for Mackenzie and Prince George was therefore monitored on a regular basis throughout winter.

Surveys were conducted from a Bell 206 helicopter with a four-person crew, including the pilot. The helicopter travelled 30-60 m above the watercourse being surveyed, at about 80 to 150 km/hr. The crew searched for and recorded the presence of all ice-free sites and recorded all water-dependent wildlife observed. The crew recorded the location and site characteristics for all ice-free areas located, and the species, class (age/sex), and number of water-dependent wildlife observed.

Location co-ordinates for each site were determined using the aircraft's on-board Global Positioning System; for longer sites, the start and end coordinates were recorded. The size (width, length and depth) of each ice-free site, as well as the distance to adjacent cover, was estimated visually and categorised into their respective measurement classes. Site width was classified into 1 of 5 categories: <2.5 m, 2.5 to 4.9 m, 5.0 to 7.4 m, 7.5 to 9.9 m, and ≥10.0 m. Site length classes were <20 m, 20 to 99 m, 100 to 499 m, 500 to 999 m, and ≥1,000 m. The water depth at each site was classified as shallow (<0.5 m), moderate (0.5 to 1.4 m), or deep (≥1.5 m). A susceptibility to predation rating was determined for each site and were expressed as high, moderate, or low susceptibility. The rating was a function of ice-free opening size (primarily width) and proximity of the open water edge to potential predator cover (e.g., shoreline vegetation).

Photographs of each site were taken during both surveys to assist in determining differences in site characteristics between surveys, and for long term documentation of the sites; the photographs are catalogued and reside in the PWFWCP office for future reference.

Water-dependent wildlife observed were counted and classified to species and, if possible, sex and age. Trumpeter swans were classed as adult or juvenile, and ducks were classified to male or female. All goldeneyes observed were considered to be common goldeneyes (*B. clangula)* unless positively identified otherwise.

3.0 Results

A survey of the Crooked, Pack, Nation, and Parsnip Rivers and the outlets of Morfee and Tacheeda Lakes was conducted on 26 January 2000; survey time was 7.1 hrs excluding ferrying time to and from Prince George and refueling caches. Weather conditions were relatively mild (-12°C, light southerly winds) with overcast skies (75-100% cover); very light snow flurries occurred periodically in the afternoon. Ground snow cover was 100%. In the 2-week period prior to the January survey, temperatures at Mackenzie ranged from a minimum of -35°C to a maximum of -10.0°C, with a mean temperature[1] of -19.9°C for the period; for the same period, temperatures at Prince George were slightly warmer at -26.3°C, -8.9°C, and -17.7°C respectively (Appendix C; Environment Canada 2000).

One hundred and twelve (112) ice-free sites were observed at 82 locations on the January survey, ranging in size from small openings (e.g., 4 m by 2 m) to extensive river sections (>1 km) being open; some locations were comprised of up to 4, usually smaller, ice-free sites (Table 2, Appendix D). The Crooked, Nation, and Parsnip Rivers had the most ice-free sites, having 30 to 37 sites each. Ice-free sites along the Crooked River were typically shallow with slow moving water; these conditions were similarly found at the Tacheeda Lakes, Chuchi Lake and Morfee Lake outlets. All sites along the Crooked River were apparently the result of warm water springs, though faster flowing water was likely a contributing factor in the size of the open water area at a few sites. Water at sites along the Nation, Parsnip, and Pack Rivers were characteristically deeper and faster flowing. The bottom substrate present at ice-free sites ranged from silty and sparsely vegetated (Crooked River, outlets of Tacheeda, Morfee and Chuchi Lakes) to sandy and gravely (sections of Pack River) to coarse gravel and cobbles (Nation and Parsnip Rivers, and sections of Pack River). Shoreline vegetation adjacent to these watercourses, if present, included sedges *(Carex* spp.), willow *(Salix* spp.), alder *(Alnus* spp.), red-osier dogwood *(Cornusstolenifera),* black cottonwood *(Populus balsamifera* ssp. *trichocarpa),* black spruce *(Picea mariana),* and hybrid spruce *(Picea glauca x engelmannii).*

Waterfowl (swans and ducks) were observed at 22 ice-free sites during the January survey (Table 3), with an additional 10 sites having American dippers only (Appendix E). The majority of waterfowl were observed at sites along the Crooked (17) and Pack (3) River

[1] The mean temperature represents the mean of the average daily temperatures (midpoint of daily maximum and minimum temperatures; Environment Canada 1998 and 2000) for the period identified.

Table 2. Distribution, species composition, and abundance of water-dependent wildlife found using ice-free sites in the Parsnip River drainage, 26 January 2000.

	Ice-free Sites		Wildlife Observed[a]							
System	n[b]	General Location	TRUS[c]	COGO	MALL	COME	BUFF	AMDI	BEKI	BAEA
CROOKED RIVER										
	17(7)	Summit Lk to 100 FSR bridge	31(3)	6[d]	5			7		1
	7(3)	West of Crooked R Prov. Park	79(13)	18	26			7	2	
	3(0)	East side of Davie Lk								
	3(2)	Davie Lk outlet to Angusmac Crk	8(0)	24		1		9		
	2(2)	Redrocky Lk to Kerry Lk		15						
	3(1)	Kerry FSR bridge	2(0)	2						
	2(2)	Near Weedon Crk confluence		11				7		
Subtotal	**37(17)**	*Summit Lk to McLeod Lk*	**118(16)**	**76**	**36**	**1**	**0**	**30**	**2**	**1**
MCLEOD LAKE/PACK RIVER										
	2(0)	McLeod R. (lower reach & mouth)						1		
	1(1)	Pack R. (McLeod Lk to W. Coast)		74		1	1	11		
	2(2)	Tudyah Lake outlet		25		16		5		
Subtotal	**5(3)**	*McLeod Lk to Williston Res.*	**0**	**99**	**0**	**17**	**1**	**17**	**0**	**0**
NATION RIVER										
	11(0)	Near Philip Crk						3		
	6(0)	Big bend to Rainbow Crk								
	4(0)	Rainbow Crk to Thutade FSR brdg						5		
	9(1)	Thutade FSR bridge to Chuchi Lk	10(0)	6	4	1		7		
Subtotal	**30(1)**	*Williston Res. to Chuchi Lk*	**10(0)**	**6**	**4**	**1**	**0**	**15**	**0**	**0**
MORFEE LAKE										
	2(0)	Outlet of Morfee Lk						1		
Subtotal	**2(0)**	*Outlet of Morfee Lk*						1		
Tacheeda Lakes										
	2(1)	Outlet of Tacheeda Lks	7(3)					1		
Subtotal	**2(1)**	*Outlet of Tacheeda Lks*	**7(3)**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
PARSNIP RIVER										
	4(0)	Near Williston Reservoir								
	4(0)	Near Colbourne Crk confluence								
	11(0)	Isadore Crk to Hodda Crk								
	10(0)	Firth railway brdg to 800 FSR brdg						1		
	5(0)	Near Table R confluence								
	1(0)	Near Missinka Crk confluence						1		
	1(0)	Upper Parsnip R. near Arctic Lk						2		
Subtotal	**36(0)**	*Williston Res. to Arctic Lk*	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**
Total	**112(22)**		**135(19)**	**181**	**40**	**19**	**1**	**68**	**2**	**1**

[a] Species: TRUS (trumpeter swan); COGO (common goldeneye); MALL (mallard); COME (common merganser); BUFF (bufflehead); AMDI (American dipper); BEKI (belted kingfisher); BAEA (bald eagle).

[b] Total number of sites (number used by swans and ducks) identified.

[c] Total number of trumpeter swans (number of cygnets) observed.

[d] Included 1 diving duck not classed to species.

Table 3. Ice-free sites in the Parsnip River drainage used by waterfowl (swans and ducks), 26 January and 18 February 2000.

System	Site No.	Waterfowl Observed[a]	
		January Survey	February Survey
CROOKED RIVER			
Summit Lake to 100 FSR bridge			
	1	COGO(1)	TRUS (3 [2])
	2	TRUS (7 [2])	
	3	TRUS (4 [0]), COGO (1), MALL (1)	COGO (2)
	7	TRUS (7 [1]), MALL (9)	
	8		TRUS (16 [1]), COGO (5)
	9	TRUS (2 [0])	TRUS (4 [0]), MALL (4)
	11	TRUS (5 [0])	TRUS (5 [1])
	13	TRUS (4 [0]), COGO (3)	TRUS (4 [0]), COGO (6), MALL (5)
West of Crooked River Provincial Park			
	14	TRUS (4 [2])	COGO (3), MALL (2)
	16	TRUS (68 [8]), COGO (16[c]), MALL (25)	[b]TRUS (54 [8]), COGO (14), MALL (18), COME(1)
	17	TRUS (7 [3]), COGO (2), MALL (1)	[b] TRUS (14 [2]), COGO (8), MALL (2), COME (1), BUFF (2)
Davie Lake outlet to Angusmac Creek			
	20	COGO (2)	
	21	TRUS (8 [0]), COGO (22), COME (1)	TRUS (4 [0]), COGO (9)
Redrocky Lake to Kerry Lake			
	22	COGO(1)	
	23	COGO (14)	
Kerry Lake FSR bridge			
	24ii	TRUS (2 [0]), COGO (2)	
	iii		TRUS (2 [0]), COGO (4)
Near Weedon Creek confluence			
	25	COGO (8)	
	26	COGO (3)	
PACK RIVER			
McLeod Lake outlet to West Coast Energy area			
	29	COGO (74), COME (1), BUFF (1)	COGO (85), MALL (2), COME (3)
Outlet of Tudyah Lake			
	30	COGO (1), COME (2)	*not surveyed*
	31	COGO (24), COME (14)	*not surveyed*
NATION RIVER			
Outlet of Chuchi Lake			
	54	TRUS (10 [0]), COGO (6), MALL (4), COME (1)	*not surveyed*
TACHEEDA LAKES OUTLET			
	76ii	TRUS (7 [3])	TRUS (10 [3])

[a] Species: TRUS (trumpeter swan); COGO (common goldeneye); MALL (mallard); COME (common merganser); BUFF (bufflehead). Total number of individuals for each species is identified in parentheses; for swans, the number of cygnets is also identified.

[b] Sites #16 and 17 became amalgamated into one site by the February survey since the ice separating them had melted. Wildlife observations, however, were still apportioned to their respective site.

[c] Includes 1 confirmed male Barrow's goldeneye.

systems, but waterfowl were also observed at the outlets of Tacheeda Lakes and Chuchi Lake; no waterfowl were observed along the Parsnip River or at Morfee Lake.

Trumpeter swans (135) and goldeneyes (181) were the most abundant species observed (Table 2 and 3, Appendix E). Swans were concentrated on the Crooked River (118 swans) with smaller numbers of birds found at the outlets of Chuchi Lake (10) and Tacheeda Lakes (7). Site #16, a long shallow site extending upstream and downstream of the 200 FSR bridge, had the most swans at 68 birds (8 cygnets), but all swans present were not in one large group. Swans were found in smaller groupings of typically 1 to 5 birds with the largest groups having about 7 individuals; however, groups were frequently found in close proximity to one another. Numbers at other sites ranged from 2 to 10 swans; the largest group was found at the outlet of Chuchi Lake. Cygnets were only present at the Crooked River and Tacheeda Lakes sites and represented 14.1% of the swans surveyed. Although swans were not observed at Parsnip River sites, feces and tracks that appeared to be from swans were found at the edge of one Parsnip site (#77). Goldeneyes were observed primarily on the Crooked and Pack Rivers ($n_{Crooked}$=76, 34 males, 38 females, 4 unclassified; n_{Pack}=99, 28 males, 71 females). One male Barrow's goldeneye *(Bucephala islandica)* was confirmed along the Crooked River (site #16).

American dippers (n=68) were the most widely distributed species, occurring at 21 sites throughout the surveyed area (Table 2; Appendix E). Other water-dependent wildlife observed included 40 mallards (25 males, 13 females), 19 common mergansers (1 male, 18 females), 1 female bufflehead (*B. albeola)*, 2 belted kingfishers *(Ceryle alcyori)*, and 1 adult bald eagle *(Haliaeetus leucocephalus)*. A lynx *(Lynx canadensis)* was observed at the outlet of Chuchi Lake along the edge (lake portion) of the open water; the lynx was within 50 m of the swans present at the site.

Since some funding was still available subsequent to the January survey, a second shorter survey was scheduled to assess changes in the size and number of ice-free sites and changes in the distribution and abundance of waterfowl. The survey was restricted to areas that had trumpeter swans present on the January survey, the Crooked River and Tacheeda Lakes; Chuchi Lake outlet was not resurveyed due to financial constraints.

The second survey (3.0 hrs) was conducted in the morning of 18 February 2000. Weather conditions were mild (-6°C, light southerly wind) with overcast skies (ceiling at approximately 1,100 m). Light snow flurries were present north of Kerry Lake, and fog was present at Tacheeda Lakes. During the 2 weeks preceding the survey, the mean daily

temperature averaged -12.6°C (max-min range: 1.5 to -30.0°C) at Mackenzie and -10.7°C (max-min range: 7.2 to -26.0°C) at Prince George (Appendix C, Environment Canada 2000).

The number and location of ice-free sites remained essentially the same for the 42 sites resurveyed along the Crooked River, McLeod Lake/Pack River, and Tacheeda Lakes during the February survey; only 1 location with 4 small previously ice-free sites (#15i-iv) had become completely frozen over and 2 new small sites (#15B and 21B) were identified on the February survey (Table 4, Appendix D). For some sites, however, their size (length and/or width) had changed: 16 had decreased and 10 had increased in size, though in most cases their size classification did not change (Appendix D). In one case, the 75-metre stretch of ice separating two nearby sites along the Crooked River (#16 and 17) had thawed and resulted in them becoming one longer site by the February survey; both sites were already each greater than 1 km in length on the January survey.

Trumpeter swans were again located primarily on the Crooked River (106 of 116 birds; Tables 3 and 4). Though swan site fidelity between the two surveys was relatively weak (8

Table 4. Distribution, species composition, and abundance of water-dependent wildlife found using ice-free sites in the Parsnip River drainage, 18 February 2000.

	Ice-free Sites		Wildlife Observed[a]							
System	n[b]	General Location	TRUS[c]	COGO	MALL	COME	BUFF	AMDI	BEKI	BAEA
Crooked River										
	17(6)	Summit Lk to 100 FSR bridge	32(4)	13	10			16		1
	4(3)	West of Crooked R Prov. Park	68(10)	25	22	2	2	4		1
	3(0)	East side of Davie Lk								
	3(1)	Davie Lk outlet to Angusmac Crk	4(0)	9				7		
	3(0)	Redrocky Lk to Kerry Lk								
	3(1)	Kerry FSR bridge	2(0)	4						
	2(0)	Near Weedon Crk confluence						4		
Subtotal	**35(11)**	*Summit Lk to McLeod Lk*	**106(14)**	**51**	**32**	**2**	**2**	**31**	**0**	**2**
McLeod Lake/Pack River										
	2(0)	McLeod R. (lower reach & mouth)								
	1(1)	Pack R. (McLeod Lk to W. Coast)		85	2	3		7		
Subtotal	**3(1)**	*McLeod Lk to Williston Res.*	**0**	**85**	**2**	**3**	**0**	**7**	**0**	**0**
Tacheeda Lakes										
	2(1)	Outlet of Tacheeda Lks	10(3)					3		
Subtotal	**2(1)**	*Outlet of Tacheeda Lks*	**10(3)**	**0**	**0**	**0**	**0**	**3**	**0**	**0**
Total	**40(13)**		**116(17)**	**136**	**34**	**5**	**2**	**41**	**0**	**2**

[a] Species: TRUS (trumpeter swan); COGO (common goldeneye); MALL (mallard); COME (common merganser); BUFF (bufflehead); AMDI (American dipper); BEKI (belted kingfisher); BAEA (bald eagle).

[b] Total number of sites (number used by swans and ducks) identified.

[c] Total number of trumpeter swans (number of cygnets) observed.

of 14 sites[2] used on both surveys), the majority (64%) of swans on the Crooked River were concentrated at sites #16 and 17 and over 95% were found using sites between Summit and Davie Lakes during both surveys (Table 3). Individual group sizes were similar to the January survey with birds in groups of 8 or less, except for the Tacheeda Lakes site that had 10 swans present. Inter-site movement was high as only 2 sites (#13 and 24) had the same number and composition of swans present on both surveys; bird composition at the rather isolated Tacheeda Lakes site also changed as an additional 3 adult swans were present on the February survey. Fourteen cygnets, 2 less than the January survey, were observed at sites along the Crooked River on the February survey; 3 cygnets were still present at the Tacheeda Lakes outlet. The proportion of cygnets in the February surveyed population was 14.7%. Swan tracks were observed at the edge of one of the new sites (#21B).

Goldeneye numbers were roughly the same for resurveyed sites (January - 150 birds, February - 136 birds) though they showed less site fidelity and greater site use and inter-site movement than the swans (Table 3 and 4, Appendix E). Site #29 on the Pack River had the greatest number of goldeneyes on both surveys: 74 birds in January and 85 birds in February. The numbers of other water-dependent species at resurveyed sites were also relatively consistent between surveys; for example, mallards (36 vs. 34) and American dippers (43 vs. 41).

Waterfowl were not observed at any ice-free sites that were narrower than 2.5 m or deeper than 1.5 m during either survey, and only 1 site less than 20 m in length was used (site #7i) (Figure 2, Appendices D and E). Also, 11 of 14 sites that were longer than 500 m or wider than 7.5 m were used by waterfowl. All larger sites found on the Crooked, Pack and Nation Rivers were used by waterfowl; the 3 unused larger sites were all located on the Parsnip River where no wildlife were found along its entire length (Figure 2). Although no sites with a high susceptibility-to-predation rating were used by waterfowl, there was no apparent relationship between the site's susceptibility rating and the presence of waterfowl (Appendix D and E).

The majority of waterfowl were observed swimming and feeding within the open water areas, though some individuals (mostly swans) were found loafing on the ice edge adjacent to an open water area. When approached with the helicopter, birds typically swam in the

[2] Sites 24ii and 24iii were considered one site for this comparison due to their close proximity (approx. 10m).

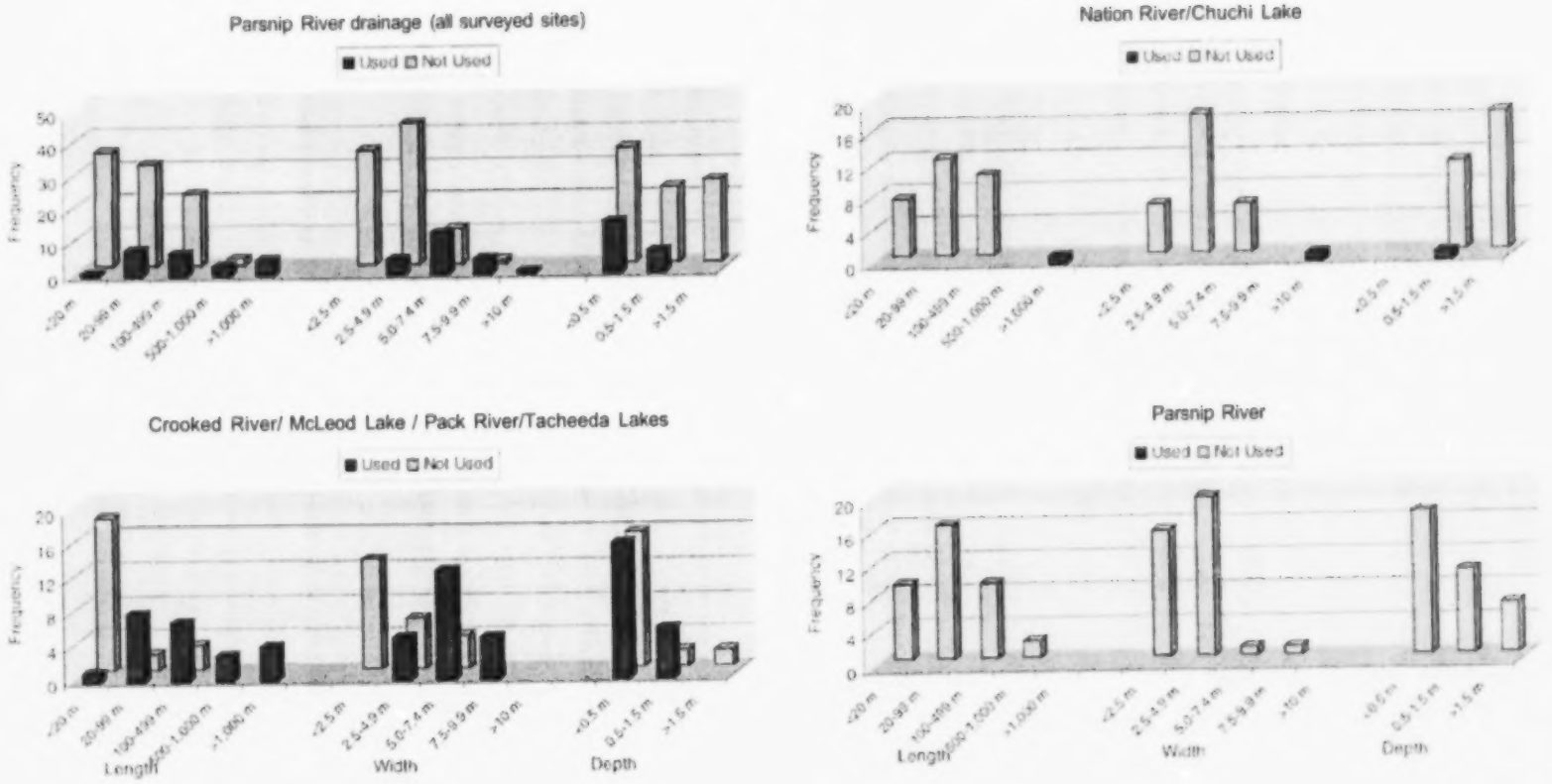

Figure 2. Waterfowl (swans and ducks) use and non-use of ice-free sites, based on site characteristics (length, width, and depth), within the Parsnip River drainage and at specific river systems, Williston Reservoir watershed, 26 January and 18 February 2000.

opposite direction and, for goldeneyes and mergansers specifically, some dove on one or more occasion. Only a few birds attempted to fly and fewer still actually rose into the air, with goldeneyes, mergansers and American dippers being the most flighty. Almost all birds that did get airborne returned to the same or adjacent ice-free site quickly, though American dippers sometimes moved from one ice-free site to the next.

4.0 Discussion

Although over 110 ice-free sites were located and were found to be relatively well distributed along the major rivers in the Parsnip River drainage, only 21% of these sites were used by waterfowl and all but 2 of these sites (outlets of Tacheeda and Chuchi Lakes) were within the Crooked/Pack River system. This was not unexpected as prior known use by wintering waterfowl had been essentially limited to the Crooked River in the Williston Reservoir watershed (MELP and Prince George Naturalists Club [PGNC] unpublished data; see Appendix F). It is believed that the faster and deeper water and the coarser bottom substrate present at the Parsnip and Nation Rivers make these sites less favourable to waterfowl and other water-dependent wildlife. Also, sites present in these areas are often frozen over (King 1981, D. King and J. Tuck, MELP, personal communication), consequently water-dependent wildlife are likely less familiar with their availability.

Winter trumpeter swan use has been reported along the Crooked River since the 1970s (Appendix F). Yet, because complete surveys of all sites available on the Crooked River have been infrequent, it is difficult to determine if the number of swans has changed during this period. The 118 swans observed on our January survey, however, was more than 50% greater than the highest previous counts on the Crooked River. Prior to 2000, swan numbers ranged from 14 to 77 birds in any given year, with peaks in 1983 (71), 1988 (72), 1993 (72), and 1998 (77) (Appendix F); more swans were likely present in 1988 and 1998 though, as these surveys were conducted from road access points. It is unknown if the 5-year interval for these previous high swan counts is coincidence or biologically based. In addition to the Crooked River, up to a dozen swans are frequently observed at the outlet of Tacheeda Lakes (D. King, MELP, personal communication) and about 20-25 birds have been observed at the outlet of Chuchi Lake (P. Koropatnisky, personal communication).

An increase in the trumpeter swan population is a partial reason for the high swan count. But, based on past winter counts in the area and reported annual population growths (up to 11% per year; McKelvey et al. 1988), it is very unlikely that an increased population is the

only contributing factor. The greater number of swans observed in 2000 is more likely due to milder early winter temperatures that occurred in November and December 1999. The mean monthly temperatures for both Prince George and Mackenzie were a few degrees warmer than normal for those months (Table 1; Environment Canada 2000). King (1981) states that persistent cold weather in early winter causes fewer numbers of swans to remain in the Central Interior (King 1981). Consequently, these warmer conditions and presumably the associated greater number and size of ice-free sites that were available likely resulted in more birds staying in the area for winter. The presence and size of ice-free sites may be more dependent on the duration of freezing temperatures (e.g., starting in early winter) rather than colder than normal temperatures occurring later on in winter, as they did in January and February 2000. Unfortunately, no surveys were conducted at other Central Interior wintering areas to see if their swan numbers were also high.

Our data suggests that site fidelity is relatively low and that significant inter-site movement takes place by wintering waterfowl along the Crooked River. Most of the swan movement appeared to occur along the 20-km section between Summit and Davie Lakes, though the number of swans observed at the more isolated Tacheeda Lakes site was also different between the 2 surveys. King (1981) similarly noted that swans shifted their location frequently at other Central Interior sites, even within the same day. These observations may imply that food resources are scarce and that access to new feeding sites may be changing (i.e., ice melt) on a daily basis, thus making it beneficial for birds to search out newly exposed areas. Supporting this argument is that the majority (64%) of swans on the Crooked River were located at sites #16 and 17, that one of the new sites (#21B) identified during the second survey had swan sign present, and that swans were found in small groups. Sites #16 and 17 were long and shallow ice-free areas and even became amalgamated by the February survey. Therefore, searching for small, newly exposed food sources could be carried out on a continuous basis over a large area without the necessity of flying, which is energetically costly. Consequently, this may be why all the larger sites (i.e., longer than 500 m or wider than 7.5 m) on the Crooked and Nation Rivers were used. The use of larger sites is also probably beneficial as they provide better escape opportunities from predators.

In most years, secondary sites used by swans such as those at Chuchi Lake and Tacheeda Lakes freeze over (King 1981, D. King, MELP, personal communication). It is likely advantageous, however, for birds to search out these secondary sites as it provides another potential food source. King (1981) reported that even the primary sites in the Central Interior (e.g., Stuart, Middle, Tachie, and Crooked Rivers) will largely freeze over in extreme cold (e.g., mean monthly temperature more than 5°C below average), thereby restricting the swans

to a limited number of sites. During such conditions in the winter of 1968-69, a minimum of 100 swans died (presumably largely due to starvation) on the Stuart River and adjacent areas (King 1981). Higher site fidelity and less inter-site movement would be expected if distances between ice-free sites were greater because of the increased energetic costs required to continually fly between sites. Swan movement between the Crooked River and other Central Interior sites is thought to be minimal or non-existent.

The limited literature on trumpeter swans wintering in the Central Interior has indicated that they are part of the Pacific Coast Population (PCP) (Campbell et al. 1990, McKelvey and Burton 1983, King 1981). This has been supported by the fact that the few banded birds found to winter in the Central Interior were from the Alaskan breeding population (McKelvey and Burton 1981, MELP unpublished data). However, as yet, no banded birds have been observed in the Williston Reservoir watershed. And, there is a large disparity in the proportion of cygnets observed along the Crooked River and other Central Interior wintering grounds. From best-count yearly surveys of the Crooked River since 1983, cygnet numbers have been quite variable but averaged 16% (range: 2 to 28%; Appendix F), comparable to our 2000 survey cygnet proportion of 14%. This is noticeably lower than the average 29% cygnet representation in the other Central Interior wintering locals (King 1981).

Perhaps the Crooked River swans are part of the PCP (either from the Alaskan breeding population or an associated breeding group) but the possibility exits that they are part of the Interior Canada subpopulation of the Rocky Mountain Population (RMP) that breeds in Alberta, northeastern BC, southern Yukon Territory and southwestern Northwest Territories. The RMP has increased in past decades but not to the same degree as the PCP (Anonymous 1999, CWS 1992); the RMP is less than one sixth the size of the PCP (Anonymous 1999). There has been much concern about the RMP as their only known wintering grounds, which are found in the tri-state area of Montana, Idaho, and Wyoming, is highly vulnerable to catastrophic events (Anonymous 1999, CWS 1992, McKelvey et al. 1988). Therefore, the identification and conservation of any additional wintering areas that may be used by swans from the RMP would assist in the conservation of the population.

Nonetheless, independent of their origin, swans are sensitive to disturbance (Hansen et al. 1971) and vulnerable to winter conditions (Anonymous 1999, King 1981). Hence, it would be advantageous to their survival to ensure that activities such as snowmobiling and logging, that may cause increased stress or disturbance to already potentially poor conditioned birds, be kept to a minimum in areas adjacent to wintering sites. Displacement of birds from available sites could concentrate birds on fewer and less favourable locations and thereby

increase the likelihood of significant losses (e.g., starvation due to accelerated depletion of food sources).

Prior winter observations of ducks in the Parsnip River drainage were not tabularised in Appendix F as records were sparse and often non-specific; the few wintering Canada goose observations have been noted for documentation purposes (MELP, unpublished data). Specific information for wintering American dippers is scant for the area but Campbell et al. (1997) indicate that relatively few dippers winter in the northern half of the province. Their wide distribution and observed use of any sized open water area during our survey infers that small numbers of dippers are likely scattered throughout the watershed, wherever an ice-free site occurs. Local bird enthusiasts suggest that goldeneye and American dipper numbers that we observed were likely high but that such an intensive survey had not been conducted before (S. Kinsey and J. Bowling, PGNC, personal communication). In order to obtain reliable counts for tracking trends in winter waterfowl and other water-dependent wildlife populations, it is evident that aerial surveys are essential as ground surveys are unable to survey more remote sites or even fully survey accessible sites.

5.0 Summary

Prior to our 2000 surveys, no formal survey had been conducted to identify the abundance and distribution of winter ice-free sites and their use by wildlife in the Williston Reservoir watershed[3]. In previous years, surveys or incidental sightings of waterfowl in the Parsnip River drainage were not always comprehensive and, at most, only identified the general location of their observation. Therefore, our surveys provide the first detailed assessment of winter ice-free sites and their use by wildlife in the Williston Reservoir watershed. Our surveys recorded the highest number of swans ever located on the Crooked River (118 birds) and, consequently, in the Parsnip River drainage (135 birds). Although we were unable to specifically identify the core wintering sites that consistently remain ice free during most winters, those sites that were frequented by waterfowl, particularly those that were used on both surveys, likely provide the best feeding opportunities for wintering waterfowl in the Williston Reservoir watershed. Conducting another survey of the Crooked River system in a year with below normal temperatures in early and mid-winter would be advantageous in identifying these core areas; such a survey would only require 3-4 hours of helicopter time and could be conducted opportunistically.

[3] A similar survey was conducted by Robertson et al. (1996) on the Peace River downstream of the WAC Bennett and Peace Canyon Dams in February 1996. Common mergansers and bald eagles were most prevalent; swans were not observed and are not known to winter in the area.

6.0 Acknowledgements

We would like to thank those people (Appendix A) that were contacted regarding potential ice-free sites in the Williston Reservoir watershed, in particular Dave King and Jim Tuck of the Ministry of Environment, Lands and Parks. And, many thanks to the Prince George Naturalists Club for providing invaluable swan census data. Assistance on the surveys was provided by Mari Wood (PWFWCP, Prince George) and Brad Arner (Ducks Unlimited, Prince George). Greg Altoft (Northern Mountain Helicopters, Prince George) piloted both survey flights.

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8.0 Appendices

Appendix A. Local residents, aircraft pilots, and personnel from resource agencies contacted to identify potential ice-free areas within the Williston Reservoir watershed.

Dave King, Glen Watts, Ted Zimmerman, Don Cadden, and Lyle Larson (MELP, Prince George)

Jim Tuck (MELP, Mackenzie)

Mari Wood, Brian Blackman, Arne Langston, and Randy Zemlak (PWFWCP, Prince George)

Chief Ella Pierre and Jean Isaac (Tsay Keh Dene).

Brian Bissett and Gordon Haley (BC Forest Service, Mackenzie).

Greg Altoft and Dean Scarrow (Northern Mountain Helicopters, Prince George)

Lyn Robinson and Dan Chase (Northern Mountain Helicopters, Mackenzie).

Brian Blackman (PWFWCP, Prince George)

Pierre Bock (Canadian Helicopters, Prince George).

Larry Frey and Eric Steir (Vanderhoof Flying Services, Vanderhoof).

Murray McCulloch (McLeod Lake)

Vi, John, and David Lambie (Mackenzie)

Scott Muller (Germansen Landing)

Line Giguere (LG Wildlife Consulting, Mackenzie)

Shannon Walshe (Pacific Slope Consultants, Mackenzie)

Pete Koropatnisky (Chuchi Lake)

Appendix B. Potential winter ice-free areas within the Williston Reservoir watershed. Sites with their *Overall Ranking value* in bold type were surveyed in 2000.

Drainage Area	River System		Potential Ice-Free Sites	Ice-free Potential	Wildlife Use Pot.	Overall Ranking
Parsnip	Parsnip R	•	Parsnip R.	L	L-N	**L-N**
		•	mouth of Arctic Lk	M-H	L-M	**M**
	Hominka R	•		L-M	L	**L**
	Crooked R	•	~1 km N of Teapot Mtn	H	H	**H**
		•	~8 km N of Teapot Mtn	H	H	**H**
		•	FSR road bridge (near The Pas mill)	H	H	**H**
		•	S of Caine Ck confluence	H	H	**H**
		•	S of Davie Lk	H	H	**H**
		•	just N of Davie Lk	H	H	**H**
		•	Redrocky Lk area	H	H	
		•	Kerry Lk FSR bridge			
	Tacheeda Lk	•	east end of lake	H	H	**H**
	McLeod Lk	•	north end of lake	H	H	**H**
	Misinchinka R	•	various spots along river (from Azu down)	M-H	L-N	**L**
	Morfee Lk	•	outlet of lake	M-L	L-M	**M**
	Nation R	•	east end of Chuchi Lk	M	M-H	**M**
		•	rapids near road crossing (55 22'/123 42')	M	N	**L-N**
		•	12 km on Nation FSR, near rec site	M-L	N	**N**
	Blackwater Ck	•	downstream of road (small sites)	L	N	N
	Manson Lks	•	betw. Manson Lakes	M-L	L-N	L
		•	betw. upper Manson Lk and Granite Ck	M-L	L-N	L
Omineca	Omineca R	•	spots betw. Osilinka and Germansen Lndg	N-L	N	N
		•	Germansen Landing bridge	L-N	N	N
		•	confluence of Nina Ck	N-L	N	N
		•	confluence of Discovery Ck	N-L	N	N
	Nina Lk	•	swampy area at mouth	L-M	N-L	L
	Osilinka R	•	8 km bridge	M	N	N
		•	N of 20 km bridge	M	N	N
		•	Uslika Lake (S end)	L-M	L-N	L
	Mesilinka R	•	56 15'/124 38' (Gopherhole Ck area?)	L-N	N	N
		•	Mesilinka bend area	M-L	N-L	L
		•	Carina Lake (mid-way up & outlet)	L-N	L-N	N
		•	SE of Blackpine (Tutizika Ck confluence)	L-N	N	N
Finlay	Ospika R	•	near Arm	L	L-N	N
		•	springs at top end	N-L	N	N
	Davis R	•	different sections throughout river	M	N	N
	Ingenika R	•	W end of Delkuz Lk	L-N	N-L	N
	Pelly Lk	•	betw. Lakes	N-L	N-L	N
	Finlay R	•	Deserters Canyon at bridge	L	N	N
		•	W of Finbow camp	L	N-L	N
		•	Ft. Ware bridge	L-M	N-L	L
	Kwadacha R	•	spots along river	L	N	N
Peace	Reservoir	•	betw. Bernard Ck and Nabesche R.	N-L	N	N
	Carbon Ck	•	betw. The Monarch and Beattie Peaks	L-N	N	N
	Donnan Lk	•	marshy area along shore	L-N	N	N

Appendix C: Temperature data for Mackenzie and Prince George, January-February, 2000. Data provided by Environment Canada (2000).

Mackenzie Townsite (695 m)

Date	Maximum	Minimum	Mean
01 Jan	-10.5	-15.0	-12.8
02 Jan	-12.0	-20.0	-16.0
03 Jan	-12.0	-23.0	-17.5
04 Jan	-5.0	-18.0	-11.5
05 Jan	-2.0	-11.0	-6.5
06 Jan	-0.5	-5.0	-2.8
07 Jan	0.5	-2.0	-0.8
08 Jan	1.0	-5.0	-2.0
09 Jan	-4.0	-8.0	-6.0
10 Jan	-7.0	-12.5	-9.8
11 Jan	-15.0	-24.0	-19.5
12 Jan	-19.0	-31.0	-25.0
13 Jan	-18.0	-25.0	-21.5
14 Jan	-15.0	-24.0	-19.5
15 Jan	-17.0	-29.0	-23.0
16 Jan	-21.5	-28.0	-24.8
17 Jan	-20.0	-32.0	-26.0
18 Jan	-20.0	-35.0	-27.5
19 Jan	-18.5	-23.0	-20.8
20 Jan	-10.0	-22.5	-16.3
21 Jan	-10.0	-20.0	-15.0
22 Jan	-10.0	-20.0	-15.0
23 Jan	-10.0	-20.0	-15.0
24 Jan	-11.0	-23.0	-17.0
25 Jan	-11.0	-14.0	-12.5
26 Jan	-7.5	-15.0	-11.3
27 Jan	-2.0	-11.0	-6.5
28 Jan	1.0	-5.0	-2.0
29 Jan	2.0	-5.0	-1.5
30 Jan	1.5	-14.0	-6.3
31 Jan	1.5	-14.0	-6.3

Jan 12-25		
Max	Min	Mean
-10.0	-35.0	-19.9

January 1-31

Max	Min
2.0	-35.0

mean Max	mean Min	mean Mean
-9.1	-17.9	-13.5

Prince George airport (676 m)

Date	Maximum	Minimum	Mean
01 Jan	-1.5	-10.6	-6.1
02 Jan	-10.5	-20.1	-15.3
03 Jan	-5.5	-17.0	-11.3
04 Jan	0.8	-5.5	-2.4
05 Jan	-1.1	-8.0	-4.6
06 Jan	0.2	-2.5	-1.2
07 Jan	1.6	-1.3	0.2
08 Jan	2.9	-6.7	-1.9
09 Jan	-2.1	-6.8	-4.5
10 Jan	-5.5	-17.0	-11.3
11 Jan	-11.1	-18.4	-14.8
12 Jan	-12.1	-18.2	-15.2
13 Jan	-14.5	-18.3	-16.4
14 Jan	-17.8	-21.4	-19.6
15 Jan	-17.1	-25.3	-21.2
16 Jan	-15.2	-25.3	-20.3
17 Jan	-13.8	-16.7	-15.3
18 Jan	-14.2	-24.9	-19.6
19 Jan	-16.0	-26.3	-21.2
20 Jan	-18.0	-24.9	-21.5
21 Jan	-15.4	-24.5	-20.0
22 Jan	-13.0	-21.9	-17.5
23 Jan	-12.5	-23.3	-17.9
24 Jan	-8.9	-12.8	-10.9
25 Jan	-10.8	-13.0	-11.9
26 Jan	-8.3	-12.3	-10.3
27 Jan	0.0	-13.9	-7.0
28 Jan	0.9	-8.7	-3.9
29 Jan	1.9	-11.9	-5.0
30 Jan	-4.9	-18.8	-11.9
31 Jan	4.5	-14.6	-5.1

Jan 12-25		
Max	Min	Mean
-8.9	-26.3	-17.7

January 1-31

Max	Min
4.5	-26.3

mean Max	mean Min	mean Mean
-7.6	-15.8	-11.7

continued...

Mackenzie Townsite (695 m)

Date	Maximum	Minimum	Mean
01 Feb	1.0	-5.0	-2.0
02 Feb	1.0	-5.0	-2.0
03 Feb	-2.5	-9.5	-6.0
04 Feb	-2.5	-15.0	-8.8
05 Feb	-3.5	-18.5	-11.0
06 Feb	1.5	-18.5	-8.5
07 Feb	-4.0	-17.5	-10.8
08 Feb	0.5	-21.0	-10.3
09 Feb	-5.5	-12.0	-8.8
10 Feb	-10.5	-20.0	-15.3
11 Feb	-11.0	-25.0	-18.0
12 Feb	-9.5	-26.0	-17.8
13 Feb	-9.0	-30.0	-19.5
14 Feb	-10.0	-25.0	-17.5
15 Feb	-3.0	-15.0	-9.0
16 Feb	-2.5	-16.5	-9.5
17 Feb	-3.5	-20.0	-11.8
18 Feb	-3.5	-7.5	-5.5
19 Feb	3.0	-7.0	-2.0
20 Feb	4.0	-7.5	-1.8
21 Feb	5.0	-1.0	2.0
22 Feb	2.5	-2.5	0.0
23 Feb	6.5	-5.0	0.8
24 Feb	6.0	-3.0	1.5
25 Feb	5.0	-8.0	-1.5
26 Feb	4.5	-1.5	1.5
27 Feb	1.5	-6.0	-2.3
28 Feb	1.0	-11.0	-5.0
29 Feb	6.5	-7.0	-0.3

February 1-29

Max	Min				
6.5	-30.0				
mean Max		mean Min		mean Mean	
-1.1		-12.6		-6.9	

Feb 4-17

Max	Min	Mean
1.5	-30.0	-12.6

Prince George airport (676 m)

Date	Maximum	Minimum	Mean
01 Feb	4.0	-1.5	1.3
02 Feb	0.2	-9.4	-4.6
03 Feb	-4.2	-13.4	-8.8
04 Feb	-8.9	-13.3	-11.1
05 Feb	-9.5	-11.7	-10.6
06 Feb	-8.8	-13.4	-11.1
07 Feb	4.7	-13.4	-4.4
08 Feb	7.2	-1.8	2.7
09 Feb	-1.8	-8.9	-5.4
10 Feb	-6.1	-19.4	-12.8
11 Feb	-10.6	-24.1	-17.4
12 Feb	-10.2	-26.0	-18.1
13 Feb	-10.8	-24.0	-17.4
14 Feb	-8.9	-24.2	-16.6
15 Feb	-5.4	-18.5	-12.0
16 Feb	-2.4	-16.4	-9.4
17 Feb	-1.6	-10.4	-6.0
18 Feb	-0.5	-12.2	-6.4
19 Feb	1.8	-7.8	-3.0
20 Feb	3.3	-1.5	0.9
21 Feb	6.3	-1.7	2.3
22 Feb	10.0	-3.1	3.5
23 Feb	6.0	-4.0	1.0
24 Feb	4.9	-3.7	0.6
25 Feb	3.3	-6.3	-1.5
26 Feb	2.8	-4.1	-0.7
27 Feb	-0.3	-7.1	-3.7
28 Feb	2.1	-4.7	-1.3
29 Feb	6.2	-3.9	1.2

February 1-29

Max	Min				
10.0	-26.0				
mean Max		mean Min		mean Mean	
-0.9		-10.7		-5.8	

Feb 4-17

Max	Min	Mean
7.2	-26.0	-10.7

Appendix D. Characteristics of ice-free sites surveyed within the Parsnip River drainage, 26 January and 18 February, 2000.

			Start				End				Jan 26 Survey						Feb 18 Survey	
			Latitude		Longitude		Latitude		Longitude		Site Characteristics							
Watershed	Site No.	General Location	Deg	Min	Deg	Min	Deg	Min	Deg	Min	Length	Width	Depth	Susc.	Comments	Site status	Comments
Crooked	1	Summit Lk to 100 FSR bridge	54	19.69	122	40.18					2	3	1	L	horseshoe shaped	reduced	slightly, d/s legs iced in more
	2		54	20.41	122	40.17					3	3	1	M		similar	
	3		54	20.82	122	40.04					3	4	1	M		similar	
	4		54	21.24	122	39.69	54	21.24	122	39.45	3	2	2	H	faster water	increased	faster water, d/s part more open
	5		54	21.99	122	38.91					1	1	1	M	2 small open sites	2 reduced	slightly
	6		54	22.14	122	38.93					1	1	1	M	3 small areas	3 similar	
	7i		54	22.30	122	38.81					1	2	1	L		increased	slightly
	7ii										2	2	1	L		increased	
	8		54	22.44	122	38.62	54	22.85	122	38.33	4	3		L	near railway culvert (54 22.672 / 122 38.372)	increased	slightly
	9		54	22.88	122	38.38	54	23.34	122	38.09	4	3	1	M	long sinuous portion, upper 1/2 too shallow for divers	similar	faster water
	10		54	23.80	122	38.20					2	2	1	H	some aquatic sedge observed	similar	
	11		54	24.69	122	38.70	54	25.11	122	39.00	3	3	1	M	faster water	similar	
	12		54	24.94	122	38.64					3	3	1	M	T-shaped in forest	similar	
	13		54	26.90	122	39.24	54	26.66	122	39.34	3	4	1	L	bridge crossing, across from mill	increased	slightly
	14	West of Crooked R Prov. Park	54	27.93	122	43.54	54	26.90	122	39.24	3	3	1	M	opening in forest	reduced	slightly
	15i-iv		54	28.00	122	43.93					1	1	1	H	4 sites (all same l, w, d, susc features)	4 reduced	all 4 frozen in
	15B		54	28.44	122	43.84					1	1		H			identified this survey
	16		54	28.58	122	43.07	54	29.66	122	43.42	6	4	1	L	long and sinuous, bridge @ 54 29.079 / 122 43.019	increased	joined with # 17
	17		54	29.69	122	43.54	54	30.17	122	43.47	5	3	2	M	patch open at N end	increased	joined w/#16, & more at d/s end now
	18i-iii	East side of Davie Lk	54	32.73	122	43.37					1	2	1	M	E side of Davie Lk in scrub area; 3 sites (all same)	3 similar	
	19	Davie Lk to Redrocky Lk	54	34.17	122	44.79					1	1		L	partially iced in	reduced	frozen in mostly
	20		54	34.56	122	44.70	54	34.63	122	44.63	3	2	2	L		reduced	mostly at u/s end
	21		54	34.48	122	44-28	54	35.07	122	44.20	4	3	1	M		similar	
	21B	Redrocky Lk to Kerry Lk	54	37.81	122	43.54					1	1		M			identified this survey
	22		54	38.50	122	44-53	54	38.58	122	44-61	2	3	1	L		increased	slightly
	23		54	38.76	122	44-80	54	38.86	122	44-86	2	2	2	L		increased	twice width now
	24i	Kerry Lk FSR bridge	54	42.80	122	47.45	54	43.05	122	47.30	1	3	2	L	Kerry bridge, 3 openings	similar	
	24ii										2	3	2	L		reduced	slightly
	24iii										2	3	1	L		similar	
	25	Near Weedon Crk confluence	54	46.50	122	49.14	54	46.62	122	49.23	2	2	1	L		reduced	slightly
	26		54	46-88	122	49.44	54	47.04	122	49.55	2	2	1	M	areas in both channels	increased	slightly, d/s end frozen
McLeod/Pack	27	McLeod R, lower reach	54	59.78	123	3.07	54	59.57	123	2.81	3	1	3	M	amongst cottonwood area	reduced	1/2 width now
	28	McLeod R, river mouth	54	59.28	123	2.50					1	3	3	L		reduced	slightly
	29	Pack R., McLeod Lk outlet to nr W. Cst.	54	59.54	123	2.29	55	2.30	123	2.52	5	4	2	L		similar	changed shape
	30	Outlet of Tudyah Lk	55	6.08	123	3-92	55	6.16	123	4.15	2	4	1	L		n/a	
	31		55	6.15	123	4.29	55	6.70	123	5.88	5	3	2	L		n/a	
Nation	32i	Near Philip Crk	55	17.00	123	38.73	55	16.89	123	39.10	2	2	3	L	downstream	n/a	
	32ii										2	2	3	L	upstream	n/a	
	33i		55	16.97	123	39.55					1	2	2	L	location taken between the 2 small openings, d/s	n/a	
	33ii										2	2	2	L	upstream	n/a	
	34		55	17.05	123	39.72	55	17.00	123	40.02	3	3	3	L	fast water	n/a	
	35		55	17.06	123	40.25	55	16.76	123	40.72	3	3	3	L		n/a	
	36		55	16.65	123	40.77	55	16.40	12	40.96	3	2	3	L		n/a	
	37		55	15.97	123	40.81					1	2	2	L		n/a	
	38i		55	15.20	123	40.69					1	2	2	L	3 smaller areas over a 500-m area	n/a	
	38ii										1	2	2	L		n/a	
	38iii										1	2	2	L		n/a	
	39i	Big Bend to Rainbow Crk	55	12.71	123	40.37	55	12.47	12	40.61	2	1	2	L		n/a	
	39ii										2	1	2	L		n/a	
	40i		55	12.48	123	40.97	55	12.46	12	41.28	2	1	3	L		n/a	
	40ii										1	2	3	L		n/a	
	41		55	12.57	123	41.84					2	1	3	L		n/a	
	42		55	13.30	123	44.00	55	13.34	123	44.23	3	2	3	L-M		n/a	
	43	Rainbow Crk to Thutade FSR bridge	55	14.93	123	59.92					2	1	2	L		n/a	
	44		55	14.58	124	2.00	55	14.61	124	2.21	2	2	3	L		n/a	
	45		55	14.42	124	5.35					2	1	2	L		n/a	
	46		55	14.40	124	6-47	55	14.55	124	6-80	3	3		L		n/a	

continued...

Watershed	Site No.	General Location	Start Latitude Deg	Start Latitude Min	Start Longitude Deg	Start Longitude Min	End Latitude Deg	End Latitude Min	End Longitude Deg	End Longitude Min	Jan 26 Survey Site Characteristics Length	Width	Depth	Susc.	Comments	Feb 18 Survey Site status	Feb 18 Survey Comments
Nation (cont'd)	47	Thutade FSR bridge to Chuchi Lk	55	11.63	124	17.00					1	2	3	L		n/a	
	48		55	11.42	124	17.79					2	2	3	L		n/a	
	49		55	11.38	124	18.37	55	11.27	124	18.50	3	3	3	L		n/a	
	50i		55	11.25	124	18.52	55	11.33	124	18.76	3	2	3	L	downstream	n/a	
	50ii										2	2	3	L	upstream	n/a	
	51		55	11.36	124	18.84	55	11.32	124	19.20	3	3	2	L		n/a	
	52		55	11.36	124	19.41	55	11.16	124	19.64	3	3	3	L		n/a	
	53		55	11.11	124	20.14	55	11.21	124	20.08	3	2	3	L		n/a	
	54		55	11.23	124	19.97	55	11.26	124	23.80	5	5	2	L		n/a	
Morfee	55	Outlet of Morfee Lk	55	21.94	123	6.45					2	1	1	M	Morfee bridge	n/a	
	56		55	21.84	123	6.24					1	2	1	M	~300 m S of #55 on W side	n/a	
Parsnip	57	Near Williston Reservoir	55	9.82	123	2.09	55	9.89	123	1.95	2	1	2	L		n/a	
	58i		55	10.03	123	1.27	55	10.03	123	0.70	2	2		M	3 narrow sections	n/a	
	58ii										2	2		L		n/a	
	58iii										1	1		L		n/a	
	59i	Near Colbourne Crk	55	4.17	122	52.01					4	1	1	M	long narrow	n/a	
	59ii										2	4		L		n/a	
	60		55	3.14	122	51.22					2	2	2	L		n/a	
	61		55	2.83	122	51.06	55	2.73	122	50.89	2	2	1	L		n/a	
	62	Isadore Crk to Hodda Crk	55	0.16	122	46.45					1	2	1	M		n/a	
	63		54	59.22	122	44.90					2	2	2	M		n/a	
	64i		54	58.02	122	42.55					1	2	1	M		n/a	
	64ii										2	1	1	L		n/a	
	65		54	57.78	122	42.46	54	57.63	122	42.60	3	2	2	L		n/a	
	66i		54	57.51	122	42.79					2	2	1	L		n/a	
	66ii										2	1	1	L		n/a	
	67		54	57.32	122	43.02	54	57.15	122	43.02	2	2	2	M		n/a	
	68		54	56.93	122	42.79					1	2	2	L		n/a	
	69i		54	56-55	122	42.51	54	56.41	122	42.42	3	1	1	M		n/a	
	69ii										1	1	1	L		n/a	
	70	Firth railway bridge to 800 FSR bridge	54	51.40	122	37.03	54	51.07	122	36.73	3	3	2	L		n/a	
	71		54	48.97	122	34.07	54	48.95	122	33.85	3	1	3	M		n/a	
	72		54	49.00	122	32.87	54	48.50	122	32.74	4	2	3	L		n/a	
	73		54	47.77	122	32.11	54	47.64	122	32.03	3	2	1	M	near Anzac confluence	n/a	
	74i		54	47.23	122	31.81	54	47.01	122	31.54	1	2	3	L		n/a	
	74ii										2	1	3	M		n/a	
	74iii										1	1	1	L		n/a	
	74iv										2	1	3	L		n/a	
	75i		54	45.99	122	29.86					1	1	1	L	Anzac bridge	n/a	
	75ii										2	2	1	M		n/a	
Tacheeda	76i	Outlet of Tacheeda Lks	54	44.20	122	30.19	54	43.74	122	30.11	1	3	1	M	patchy	reduced	frozen in more, mostly at middle & N areas
	76ii										3	3	1	M		reduced	
Parsnip	77	Near Table R	54	44.45	122	27.31	54	44.32	122	27.05	3	2	2	L	feces at S end on ice (swans?)	n/a	
	78i		54	43.90	122	26.76	54	43.84	122	26.59	2	2	2	L		n/a	
	78ii										2	1	2	M		n/a	
	79		54	43.84	122	26.59	54	43.76	122	26.47	3	2	3	M		n/a	
	80		54	42.10	122	16.69					1	1	1	L		n/a	
	81	Near Missinka Crk	54	35.01	122	2.67	54	34.73	122	2.59	3	2	1	L	Missinka	n/a	
	82	Upper Parsnip R. near Arctic Lk	54	26.43	121	44.30	54	25.95	121	42.60	3	1	1	M	portions iced in at S end of area	n/a	

Where

Length
1 = <20 m
2 = 20 to 99 m
3 = 100 to 499 m
4 = 500 to 999 m
5 = >1,000 m

Width
1 = 2.5m
2 = 2.5 to 4.9 m
3 = 5.0 to 7.4 m
4 = 7.5 to 9.9 m
5 = >10.0 m

Depth
1 = <0.5 m
2 = 0.5 to 1.5 m
3 = >1.5 m

Susceptibility is a function of opening size and proximity of open-water edge to predator cover

Appendix E. Water-dependent wildlife observed during surveys of ice-free sites within the Parsnip River drainage, 26 January and 18 February 2000.

26 JANUARY SURVEY

Watershed	Site No.	TRUS			COGO				MALL			COME			BUFF			Unk. Diver	AMDI	BEKI	BAEA	Beaver	Comments
		Total	A	J	Total	M	F	Uncl.	Total	M	F	Total	M	F	Total	M	F						
Crooked	1	0			1		1		0			0			0								
	2	7	5	2	0				0			0			0								
	3	4	4		1		1		1	1		0			0								
	4	0			0				0			0			0								
	5	0			0				0			0			0								
	6	0			0				0			0			0								
	7	7	6	1	0				9	5	4	0			0				2				
	8	0			0				0			0			0								
	9	2	2		0				0			0			0				1		1		
	10	0			0				0			0			0								
	11	5	5		0				0			0			0			1	3				unknown diver likely goldeneye
	12	0			0				0			0			0				1				
	13	4	4		3			3	0			0			0								
	14	4	2	2	0				0			0			0				3				
	15	0			0				0			0			0								
	16	68	60	8	16	8	8		25	17	8	0			0				4	2			male BAGO accounted for one COGO
	17	7	4	3	2	2			1	1		0			0								
	18	0			0				0			0			0								
	19	0			0				0			0			0								
	20	0			2	2			0			0			0								
	21	8	8		22	10	12		0			1		1	0				9				2 moose, eagle nest
	22	0			1	1			0			0			0								
	23	0			14	6	8		0			0			0								
	24a	2	2		2	1	1		0			0			0								
	25	0			8	3	5		0			0			0								otter trails on snow on river
	26	0			3	1	2		0			0			0				7				
Crooked Subtotal		**118**	**102**	**16**	**75**	**34**	**38**	**3**	**36**	**24**	**12**	**1**	**0**	**1**	**0**	**0**	**0**	1	**30**	**2**	**1**	**0**	
McLeod/Pack	27	0			0				0			0			0				1				
	28	0			0				0			0			0								
	29	0			74	18	56		0			1		1	1		1		11				
	30	0			1	1			0			2		2	0								
	31	0			24	9	15		0			14	1	13	0				5				9 wolves at mouth of Pack
McLeod/Pack Subtotal		**0**	**0**	**0**	**99**	**28**	**71**	**0**	**0**	**0**	**0**	**17**	**1**	**16**	**1**	**0**	**1**	0	**17**	**0**	**0**	**0**	
Nation	32	0			0				0			0			0								
	33	0			0				0			0			0								
	34	0			0				0			0			0								
	35	0			0				0			0			0				1				
	36	0			0				0			0			0				2				
	37	0			0				0			0			0								
	38	0			0				0			0			0								
	39	0			0				0			0			0								
	40	0			0				0			0			0								
	41	0			0				0			0			0								
	42	0			0				0			0			0								
	43	0			0				0			0			0								
	44	0			0				0			0			0								
	45	0			0				0			0			0				2				
	46	0			0				0			0			0				3				

continued...

26 JANUARY SURVEY

Watershed	Site No.	TRUS Total	TRUS A	TRUS J	COGO Total	COGO M	COGO F	COGO Unct	MALL Total	MALL M	MALL F	COME Total	COME M	COME F	BUFF Total	BUFF M	BUFF F	Unk Diver	AMDI	BEKI	BAEA	Beaver	Comments
	47	0			0				0			0			0								
	48	0			0				0			0			0								
	49	0			0				0			0			0								
	50	0			0				0			0			0								
	51	0			0				0			0			0								
	52	0			0				0			0			0								
	53	0			0				0			0			0								
	54	10	10		6	2	4		4	3	1	1		1	0				7				lynx on ice near ice-free area
Nation Subtotal		10	10	0	6	2	4	0	4	3	1	1	0	1	0	0	0	0	15	0	0	0	
Mistee	55	0			0				0			0			0				1				
	56	0			0				0			0			0								
Mistee Subtotal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
Parsnip	57	0			0				0			0			0								
	58	0			0				0			0			0								otter trails
	59	0			0				0			0			0								beaver sticks abundant in ice-free area
	60	0			0				0			0			0								
	61	0			0				0			0			0								
	62	0			0				0			0			0								
	63	0			0				0			0			0								
	64	0			0				0			0			0								
	65	0			0				0			0			0								
	66	0			0				0			0			0								
	67	0			0				0			0			0								
	68	0			0				0			0			0								
	69	0			0				0			0			0								
	70	0			0				0			0			0							1	Greg made observation, likely a beaver
	71	0			0				0			0			0								
	72	0			0				0			0			0								
	73	0			0				0			0			0				1				3 moose, mouth of Anzac
	74	0			0				0			0			0								
	75	0			0				0			0			0								
Tacheeda	75i	7	4	3	0				0			0			0				1				2 coyotes bedded on river before #78
Parsnip	77	0			0				0			0			0								tuces on ice at S end of spanning (TRUS?)
	78	0			0				0			0			0								
	79	0			0				0			0			0								
	80	0			0				0			0			0								
	81	0			0				0			0			0				1				4 wolves on kill (betw. 81&82; photos 21-20)
	82	0			0				0			0			0				2				1 rock ptarmigan
Parsnip Subtotal		7	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	

	TRSW Total	TRSW A	TRSW J	COGO Total	COGO M	COGO F	COGO Unct	MALL Total	MALL M	MALL F	COME Total	COME M	COME F	BUFF Total	BUFF M	BUFF F	Unk Diver	AMDI	BEKI	BAEA	Beaver
Crooked Subtotal	118	102	16	75	34	38	3	36	24	12	1	0	1	0	0	0	1	30	2	1	0
McLeod/Pack Subtotal	0	0	0	99	28	71	0	0	0	0	17	1	16	1	0	1	0	12	0	0	0
Nation Subtotal	10	10	0	6	2	4	0	4	3	1	1	0	1	0	0	0	0	15	0	0	0
Mistee Subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Parsnip Subtotal	7	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1
Overall Total	135	116	19	180	64	113	3	40	27	13	19	1	18	1	0	1	1	63	2	1	1

continued...

18 FEBRUARY SURVEY

Watershed	Site No.	TRUS Total	TRUS A	TRUS J	COGO Total	COGO M	COGO F	COGO Unid	MALL Total	MALL M	MALL F	COME Total	COME M	COME F	BUFF Total	BUFF M	BUFF F	Unk Diver	AMDI	BEKI	BAEA	Beaver	Comments
Crooked	1	3	1	2	0				0			0			0								
	2	0			0				0			0			0								
	3	0			2		2		0			0			0				1				
	4	0			0				0			0			0				2				open slightly more at N end
	5	0			0				0			0			0				2				
	6	0			0				0			0			0				3				1 otter
	7	0			0				0			0			0								
	8	16	15	1	5	1	4		1	1		0			0								
	9	4	4		0				4	1	3	0			0				3		1	1	beaver?
	10	0			0				0			0			0								
	11	5	4	1	0				0			0			0				3				
	12	0			0				0			0			0				1				2 moose kills on railway allowance #12
	13	4	4		6	4	2		5	4	1	0			0				1				
	14	0			3	2	1		2	1	1	0			0				2				
	15i iv	0			0				0			0			0								NO SITES EXISTED ON FEB SURVEY
	15B	0			0				0			0			0								
	16	54	46	8	14	6	8		18	10	8	1		1	0				2		1		
	17	14	12	2	8	3	5		2	1	1	1		1	2	1	1						
	18	0			0				0			0			0								
	19	0			0				0			0			0								
	20	0			0				0			0			0								
	21	4	4		9	3	6		0			0			0				5				
	21B	0			0				0			0			0				1				swan tracks in snow near open water
	22	0			0				0			0			0								
	23	0			0				0			0			0								
	24a	2	2		4	1	3		0			0			0								1 otter in second of 3 openings
	25	0			0				0			0			0								
	26	0			0				0			0			0				4				
Crooked Subtotal		106	92	14	51	20	31	0	32	18	14	2	0	2	2	1	1	0	31	0	2	1	
McLeod/Pack	27	0			0				0			0			0								
	28	0			0				0			0			0								
	29	0			85	19	53	13	2	1	1	3		3	0				7				
	30	0			0				0			0			0								
	31	0			0				0			0			0								
McLeod/Pack Subtotal		0	0	0	85	19	53	13	2	1	1	3	0	3	0	0	0	0	7	0	0	0	
Tacheeda	76ii	10	7	3	0				0			0			0				3				
Parsnip Subtotal		10	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	

	TRSW Total	TRSW A	TRSW J	COGO Total	COGO M	COGO F	COGO Unid	MALL Total	MALL M	MALL F	COME Total	COME M	COME F	BUFF Total	BUFF M	BUFF F	Unk Diver	AMDI	BEKI	BAEA	Beaver
Crooked Subtotal	106	92	14	51	20	31	0	32	18	14	2	0	2	2	1	1	0	31	0	2	1
McLeod/Pack Subtotal	0	0	0	85	19	53	13	2	1	1	3	0	3	0	0	0	0	7	0	0	0
Parsnip Subtotal	10	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Overall Total	116	99	17	136	39	84	13	34	19	15	5	0	5	2	1	1	0	41	0	2	1

Appendix F. Winter (mid- December to mid-March) surveys and incidental observations of trumpeter swans and Canada geese found using ice-free sites within the Parsnip River drainage, 1976-2000.

Date	System	Area	TRUS	CAGO	Observer(s) & Survey Method	Source[a]
30 Mar 76	Crooked R.		**21 (0)**	3	D. King; aerial	King 1981
		Teapot Mtn. - Bear Lk area	18 (0)			
		Head of Davie Lk	3 (0)			
28 Mar 77	Crooked R.		**28 (11)**	**49**	L. Erickson, B. Arthur; aerial	MELP, unpublished
		Crooked R Park - Davie Lk	3 (1)	28		
		Davie Lk - Kerry Lk	13 (4)	18		
		Kerry Lk - McLeod Lk	12 (6)	3		
	McLeod R.	Inlet to War Lk	**8 (3)**			
Jan 79	Nation R.	Inlet to Tchentlo Lk	**2(1)**		C. Nivison; aerial	King 1981
8 Feb 79	Crooked R.		**40 (5)**		K. Child; aerial	King 1981
	McLeod R.		**3 (0)**			
19 Jan 83	Crooked R.		**71 (17)**		G. Hazelwood; aerial	Campbell et al. 1990 and MELP, unpublished data
		Near Bowman Slough	6 (0)			
		Near McEwan	13 (6)			
		Near springs	11 (5)			
		100 FSR bridge - Davie Lk	41 (6)			
		Davie Lk - Kerry Lk: no open water	0			
16 Feb 83	Crooked R.	Davie Lk - McLeod Lk	**53 (2)**		G. Hazelwood; aerial	MELP, unpublished data
21 Feb 83	Nation R.	North Road - Tchentlo	**0**		D. King, R. McKelvey, F. Simpson; aerial	MELP, unpublished data
2 Feb 85	Crooked R.		**23**		PGNC members; ground	PGNC, unpublished data
17 Mar 85	Crooked R.		**1**		PGNC members; ground	PGNC, unpublished data
19 Jan 86	Crooked R.	*(from road access points)*	**30 (3)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	26 (3)			
		100 FSR bridge to Davie Lk	0			
		Davie Lk to Kerry Lk FSR bridge	4 (0)			
28 Jan 86	Crooked R.		**43 (1)**		D. King, R. McKelvey, R. Brown; aerial	MELP, unpublished data
11 Mar 86	Crooked R.		**15**		PGNC members; ground	PGNC, unpublished data
16 Dec 86	Crooked R.	Summit Lk - McLeod Lk	**66 (14)**		K. Child, G. Watts, S. Berry; aerial	MELP, unpublished data

continued..

Appendix F. *Continued.*

Date	System	Area	TRUS	CAGO	Observer(s)	Source[a]
11 Jan 87	Crooked R.	*(from road access points)*	**22 (6)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	6 (2)			
		100 FSR bridge to Davie Lk	11 (2)			
		Davie Lk to Kerry Lk FSR bridge	5 (2)			
10 Mar 87	Tacheeda	Outlet of lake	**~15**		unknown	MELP, unpublished data
17 Jan 88	Crooked R.	*(from road access points)*	**72 (20)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	24 (9)			
		100 FSR bridge to Davie Lk	32 (5)			
		Davie Lk to Kerry Lk FSR bridge	16 (6)			
15 Jan 89	Crooked R.	*(from road access points)*	**23 (4)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	2(1)			
		100 FSR bridge to Davie Lk	14(1)			
		Davie Lk to Kerry Lk FSR bridge	7 (2)			
27 Dec 89	Crooked R.		**14**		PGNC members; ground	PGNC, unpublished data
14 Jan 90	Crooked R.	*(from road access points)*	**36 (5)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	6 (0)			
		100 FSR bridge to Davie Lk	5 (0)			
		Davie Lk to Kerry Lk FSR bridge	25 (5)			
13 Mar 90	Crooked R.		**42 (6)**		D. King, D. Stevenson; aerial	MELP, unpublished data
		Summit Lk - Prov. Park	5(1)			
		Prov, park - Davie Lk	11 (2)			
		Davie Lk - Redrocky Lk	22 (3)			
		Redrocky Lk - Kerry Lk	4 (0)			
15 Mar 90	Crooked R.		**59 (7)**	4	K. Child, S. Berry; aerial	MELP, unpublished data
	Nation R.		**19 (10)**			
		At Chuchi Lk	19 (10)			
		Chuchi Lk - Williston Reservoir	0			
13 Jan 91	Crooked R.	*(from road access points)*	**29 (6)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	2 (1			
		100 FSR bridge to Davie Lk	27 (5)			
		Davie Lk to Kerry Lk FSR bridge	0			

continued,

Appendix F. *Continued.*

Date	System	Area	TRUS	CAGO	Observer(s)	Source[a]
12 Jan 92	Crooked R.	*(from road access points)*	**48 (12)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	17 (1)			
		100 FSR bridge to Davie Lk	0			
		Davie Lk to Kerry Lk FSR bridge	31 (11)			
16 Jan 93	Crooked R.	*(from road access points)*	**30 (1)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	0			
		100 FSR bridge to Davie Lk	30 (1)			
		Davie Lk to Kerry Lk FSR bridge	0			
Feb 93	Crooked R.		**72 (2)**		MELP staff; aerial	MELP, unpublished data
	Parsnip R.	outlet of Arctic Lk	**5**			
13 Mar 93	Crooked R.		**2**		PGNC members; ground	PGNC, unpublished data
16 Jan 94	Crooked R.	*(from road access points)*	**36 (10)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	0			
		100 FSR bridge to Davie Lk	28 (6)			
		Davie Lk to Kerry Lk FSR bridge	8 (4)			
15 Jan 95	Crooked R.	*(from road access points)*	**25 (3)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	11 (1)			
		100 FSR bridge to Davie Lk	14 (2)			
		Davie Lk to Kerry Lk FSR bridge	0			
16 Jan 96	Crooked R.	*(from road access points)*	**11 (3)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	0			
		100 FSR bridge to Davie Lk	11 (3)			
		Davie Lk to Kerry Lk FSR bridge	0			
29 Feb 96	Crooked R.		**66 (8)**		C. Vos; aerial	MELP, unpublished data
	Tacheeda L.	lake outlet	**8 (0)**			
19 Jan 97	Crooked R.	*(from road access points)*	**34 (2)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	3 (0)			
		100 FSR bridge to Davie Lk	25 (2)			
		Davie Lk to Kerry Lk FSR bridge	6 (0)			
18 Jan 98	Crooked R.	*(from road access points)*	**77 (14)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	5(1)			
		100 FSR bridge to Davie Lk	68 (12)			
		Davie Lk to Kerry Lk FSR bridge	4(1)			

continued..

Appendix F. *Continued.*

Date	System	Area	TRUS	CAGO	Observer(s)	Source[a]
17 Jan 99	Crooked R.	*(from road access points)*	**18 (4)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	0			
		100 FSR bridge to Davie Lk	14 (4)			
		Davie Lk to Kerry Lk FSR bridge	4 (0)			
27 Jan 99	Crooked R.		**48 (8)**		T. Zimmerman; aerial	MELP, unpublished data
		Summit Lk - 100 FSR bridge	14 (4)			
		100 FSR bridge - Davie Lk	26 (4)			
		Davie Lk - Kerry Lk	4 (0)			
		Kerry Lk - McLeod Lk	4 (0)			
26 Feb 99	Nation R.	2 km upstream of Sylvester Crk (55°11. 56'/124°18.46')	**14 (7)**		F. Corbould, P. Hengeveld; aerial	Hengeveld and Corbould 2000
16 Jan 00	Crooked R.	*(from road access points)*	**27 (2)**		PGNC members; ground	PGNC, unpublished data
		Summit Lk to 100 FSR bridge	6 (0)			
		100 FSR bridge to Davie Lk	16 (2)			
		Davie Lk to Kerry Lk FSR bridge	5 (0)			
26 Jan 00	Crooked R.	see report for details	**118(16)**		F. Corbould, P. Hengeveld; aerial	this report
	McLeod/Pack	see report for details	**0**			
	Tacheeda L.	see report for details	**7 (3)**			
	Parsnip/Morfee	see report for details	**0**			
	Nation R.	see report for details	**10(0)**			
18 Feb 00	Crooked R.	see report for details	**106 (14)**		F. Corbould, P. Hengeveld; aerial	this report
	McLeod/Pack	see report for details	**0**			
	Tacheeda L.	see report for details	**10 (3)**			

[a] Unpublished data was made available by Dave King (Ministry of Environment, Lands and Parks, Prince George) and Nancy Muirhead, Laird Law, and Sandra Kinsey (Prince George Naturalists Club, Prince George)